Operational Applications of Satellite Altimetry at NOAA

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2014-06-10 to 07-10
First Things First...

Thanks to:

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Anne O’Carroll & Ewa Kwiatkowska for sharing their office with me!
Agenda

1. Background & History
2. "Altimetry 101"
3. Operational Altimetry Applications
4. Accomplishments this Month
5. Questions?
Altimetry Mission Timeline & NOAA Responsibilities

- **NOAA Responsibilities**
  - NOOA Partner
  - NOAA Products

- **NOAA Partner**
  - ERS-1
  - ERS-2
  - GFO

- **NOAA Products**
  - TOPEX/Poseidon
  - Jason-1
  - Jason-2
  - HY2A
  - Envisat
  - SA
  - CS2
NOAA/NESDIS

Center for Satellite Applications & Research

Satellite Oceanography & Climatology Division

Laboratory for Satellite Altimetry

EUMETSAT

Technical and Scientific Support

Remote Sensing & Products Division

Marine Applications

Jason-2 (June, 2008) • Jason-3 (March, 2015) • Jason-CS (2020…)

EUMETSAT: 2014-07-08
“Altimetry 101”

https://www.meted.ucar.edu/EUMETSAT/jason

• Developed by EUMETSAT after Jason-2 launch
• Narrated by François Parisot - Jason Project Manager
The Radar Echo or ‘Waveform’

mid-height $\tau$: Range

$\sigma^0 : P$ (Wind)

leading edge slope: SWH

$\xi$ trailing edge slope: Attitude

Time ($\sim 0.4 \mu\text{sec}$) = 60m (2-way) Range

Low Waves

High Waves

EUMETSAT: 2014-07-08
Altimetric Sea Surface Height

Orbit, Range ~ 1300 km
SSH, Geoid ~ 100 m
Dynamic Topography ~ 1 m
Precision: 1 mm
Altimetry Applications & End Users

Sea Level Anomaly — "Ocean Weather" - 25 Mar to 4 Apr, 2014

- High Wave Warnings
- Search & Rescue
- Sea Level Rise
- Hurricane Forecasting
- Harmful Algal Blooms
- Oil Spill Tracking

EUMETSAT: 2014-07-08
NWS/OPC Jason-2 Wave Warnings on TWITTER

Near real-time comparison with WAVEWATCH III model (green contours) shows excellent agreement.

NWS/OPC AltiKa Wave Warnings on TWITTER

When strong winds oppose current, often times higher/steeper waves result. Following image highlights this phenomenon.

pic.twitter.com/nmT3QcjTES

• AltiKa SWH shows 7’ error in WAVEWATCH III model
  SWH in Gulf Stream.

• Error caused by model not correctly accounting for opposing strong winds and surface currents

WWW.TWITTER.COM/NWSOPC
U.S. Coast Guard uses Jason-derived HYCOM surface currents in their SAROPS planning app to design search patterns.

Knowing the currents allows USCG to narrow-down search zones, improving response times, saving lives and reducing operational costs.

**End Users:** USCG, federal & state agencies, private companies.
Safe Offshore Operations

Oil platform operators stop operations when energetic eddies & currents >1.5 knots.

Operators rely on ocean circulation models initialized with JASON observations to avoid accidents when raising or lowering drill strings, thereby reducing the risk of major equipment failures and environmental disasters.

End Users: Oil industry, private oceanographic service providers.
Oil Spill Response

Deep Water Horizon Oil Spill Interacting with Loop Current

- GNOME – modeling tool used operationally by NOAA Office of Response & Restoration to predict spill trajectories
- Software publicly available
- Variety of input data sets, including NOAA/RTOFS 1/12° degree global HYCOM initialized with Jason observations

End users – Federal agencies (NOAA, Coast Guard, FEMA, EPA), state & local agencies, oil companies
Monitoring Harmful Algal Blooms

Sightings of *Karenia brevis*, the cause of Red Tide along West Florida, combined with model surface currents initialized with Jason observations.

NOAA HABSOS provides physical data (currents, SST, etc.) and HAB biological data in an integrated mapping environment.

**End users:** NOAA, EPA, state & local environmental & health agencies, university researchers.

habsos.noaa.gov
Ocean Hypoxia Dead Zones

Low oxygen “dead zones” in Gulf of Mexico are monitored routinely with in-situ measurements and model currents based on Jason observations.

End Users – NOAA, EPA, state & local environmental agencies, university researchers.
Fishing Services

Jason-derived currents are used by commercial and recreational fishermen to minimize search time and boat operating costs.

End Users: fishermen, commercial ocean service providers.
Hurricane Intensity Forecasting

National Hurricane Center uses Jason data to derive ocean heat content to improve intensity forecasts as much as 3 days in advance.

Ocean heat content based on altimeter data. Katrina intensified to CAT5 while passing over Loop Current.

End Users: Federal, state & local disaster and relief agencies
Sea Level Rise

Fairly uniform increase over past 23 years. But, large La Niña “drop” in 2011 illustrates the need to maintain continuity of Jason series.

Two thirds of change due to melting of grounded ice (mass increase); one third due to ocean warming (expansion).
Search For Malaysia Flight 370

- Satellite altimeter bathymetric map of search area, including data from Jason-1 Geodetic Mission, shows highly irregular bottom topography (Smith & Marks, EOS)

- Australian acoustic contact on north slope of Zenith Plateau (red circle)

- Only 5% of the MH370 search area has been surveyed by conventional acoustic techniques.
So What Have We Done This Month? (Besides Watching World Cup 2014...)

2014 FIFA World Cup™

Matches | Groups | 2nd Stage
---|---|---
Rnd 16 | Qtr | Semi | Final | Semi | Qtr | Rnd 16

(3 – 2) Full-time
BRA 1
CHI 1

Full-time
COL 2
URU 0

Full-time
FRA 2
NGA 0

Full-time
GER 2
ALG 1

FT

Final - 7/13, 9:00 PM

7/8

7/9

Full-time
2 NED
1 MEX

(5 – 3) Full-time
1 CRC
1 GRE

Full-time
1 ARG
0 SUI

Full-time
2 BEL
1 USA

EUMETSAT: 2014-07-08
8th Coastal Altimetry Workshop - Organizing & Science
Hans & Remko

SARAL/AltiKa Workshop - Science Committee
Remko & John

OSTST - Science Committee & Plenary Sessions
Hans & John

Quantifying Errors and Uncertainties in Altimetry Data
Remko

Near Real Time Products and Applications
John & Julia Figa-Saldana
Special Issue of Marine Geodesy: SARAL/AltiKa Cal/Val

SSH with radiometer wet (cm)

Distance from coast (km)

SARAL Jason-2

AltiKa cycle-averaged Attenuation - solid line, day/night - dashed line

Mean

Std. Dev.

AltiKa Cycle-006 Backscatter Attenuation

AltiKa Cycle-006 Missing 40Hz

sla crossover rms (sa)

Backscatter Attenuation Radiometer (dB)

0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0
Altimetry & Storm Surge: T.U. Darmstadt Lecture

Hurricane Sandy: HY-2A


Cyclone Xaver: SARAL/AltiKa

EUMETSAT: 2014-07-08
Future NOAA/EUMETSAT Collaboration

**Jason-3:** Launch - March, 2015

**Sentinel-3:** Launch - Fall, 2015

- More NOAA Visiting Scientists?

**Jason-CS-A:** Launch - 2020

**Jason-CS-B:** Launch ~ 2025
Questions?

Thanks for your attention, and the opportunity to spend this month at EUMETSAT!